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AND ABSTRACT OF THE LITERATURE

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HONORARY CONSULTING EDITOR
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A. F. STANLEY KENT, A.M., D.Sc.

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Carbon Monoxide, Illuminating Gas, and Benzol: Their Effect on Blood Coagulation Time

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THE JOURNAL OF INDUSTRIAL HYGIENE

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WHEN ARE DISABILITIES OF THE BACK ARISING OUT OF PATHOLOGICAL CONDITIONS REPORTABLE ACCIDENTS?*

RUFUS B. CRAIN, M.D., AND BENJAMIN J. SLATER, B.S., M.D.

Medical Department, Eastman Kodak Company, Rochester, N. Y.

OF all the problems that confront the industrial surgeon there is none more difficult to handle than the familiar "strained back." Osgood (1), in his article read before the meeting of industrial surgeons at Atlantic City in June, 1919, has shown a very proper conception of the perplexity of the situation, and his article represents as good a medical résumé of the subject as may be found.

Almost every day the industrial surgeon is consulted by a workman who says, "I believe I have strained my back." Broadly speaking, such cases fall into two groups, the first of which is composed of strains which date from a definite experience, such as a slip or a fall, or the lifting of some unusually heavy object. These cases usually conform to our conception of what is meant by an accident as set forth by the Workmen's Compensation Law of New York State. When a workman is able to point to a particular trauma at a certain time of the day, which is unusual and not a part of his routine work, there is no problem involved. The case is always reportable, provided there is loss of time or more than first-aid treatment. The second class, however, is far more numerous and difficult to handle. Cases in this group differ from those in the first in that they are referable to no definite time or unusual experience. The workman presents himself for an examination complaining of "lumbago" or "rheumatism," with or without some rise in temperature. His usual statement is, "Doc, I believe I have strained myself lifting boxes in Department X."

"When did it happen?"

"Two or three weeks ago, I can't say exactly when."

"Did anything unusual happen?"

"No, I was simply stooping over (or lifting some boxes) and felt no pain at the time."

"When did the pain develop?"

"It came on today."

Further questioning will generally reveal the fact that the workman was doing his regular work in a routine manner without the occurrence of a single incident which might be thought to be apart from the ordinary routine of his work. We have found that the onset in this particular type of case is not so dramatic as that in class one. The consequences, however, may be, and frequently are, quite as serious. It was

* Received for publication Sept. 1, 1921.

formerly our custom to report all of these cases as accidents. They have, however, become so serious and so numerous, and have shown such a large variety of etiological factors, when carefully studied, that we now hesitate before reporting them as accidents. Fortunately, under the existing state compensation law we are permitted ten days in which to report an accident, and it is during this time that we investigate through the workman's department the circumstances attending the disability and make a thorough medical examination of the case, including X-ray examination, Wassermann, and a thorough physical examination.

It is our opinion that of this latter type of case each has developed from some focus of infection. Only occasionally have we been unable to demonstrate such a focus. Certainly, nine cases out of ten are, in our opinion, not reportable accidents within the meaning of the workmen's compensation law. The most common causes in this group of cases have been thought to be faulty posture, infected teeth or tonsils, syphilis, tuberculosis, weak feet, etc. Indeed, it is really surprising to find the number of cases of chronic disease which are encountered, in which a workman feels that his condition is due to some slight injury, and it is in the handling of these chronic diseases that we are confronted with our most serious problems. Often the only complaint which a workman will have is a strained back, and upon thorough examination some other condition will be discovered. It is not uncommon to hear a workman say, "I have not been so well since I was hurt," when he is really suffering from advanced tuberculosis, syphilis, or some other chronic disease. A great many workmen are entirely unfamiliar with the workmen's compensation law and regard themselves as victims of an accident without any consideration of what is really wrong with them, or of the manner in which their disability has developed. The following three cases taken from a much larger group are illustrative of the points under discussion:

Case 1. — L. H., female, 37 years of age, and weighing 140 pounds, at 3 P.M. on April 6, 1918, in the course of her ordinary employment, reached to pick up from a basket placed on the floor a small object weighing about 2 ounces. This was a part of her routine work. On this particular occasion, she felt something slip in her back, became unable to move her right leg, and three or four days later became almost completely disabled. She did not slip or fall, and there appeared to be nothing unusual about the manner in which her disability developed. The case was reported as a right sacro-iliac strain, and the woman was referred to a specialist who applied a cast and, later, a brace. Her case dragged along for two years, during the greater part of which period she did not work. In her particular case, it seemed as though there was some malingering, inasmuch as she was often seen to walk in a perfectly normal manner, whereas, before the Industrial Commission, she would appear almost a complete invalid. A contest was raised, after two years, that an accident was never sustained. The Industrial Commission closed the case on the ground that there was no accident.

The interesting feature, which this case illustrates, is that an employee may develop a disabled condition of the back which is not a reportable accident and should not be reported as such.

Case 2. — E. M., male, 46 years of age, and weighing 186 pounds, on December 12, 1918, leaned forward in the course of his ordinary employment and lifted from one stall to another a jar of liquid weighing about 50 pounds. The vertical lift was 2 feet, and the horizontal, about $1\frac{1}{2}$ feet. He had been performing this particular operation for many years, but on this particular occasion was seized with a terrific pain in the region of the right sacro-iliac joint, became incapacitated, and was taken home. There is no record, in this case, of the man's having slipped or fallen, or of his having been struck. He was apparently performing a routine operation in a routine way. His case was reported as a sacro-iliac strain. During the course of treatment by a specialist, he developed a phlegmasia alba dolens and, later, cystitis and varicose ulcers of the right leg. He has drawn compensation at intervals since the period of injury. While the final award has not been

made in this case, it is easy to see that the amount involved is very considerable, and it is difficult to understand how this can be called an accident even though it was so ruled by the Industrial Commission.

This case differs from that of L. H. in only one respect, namely, that the weights lifted were different. Nevertheless, very considerable compensation has been paid and the case is still on the calendar. It is not uncommon to have three or four such cases a month — cases in which there is a sudden seizure in the region of the sacro-iliac joints with disability for a short time. It is not often, however, that cases are as prolonged as was the case of E. M., but they are occasionally seen. The third case is somewhat different from the two which we have already described.

CASE 3. — G. A., male, 36 years old, weighing 146 pounds, was reported to have sustained an accident at 4 P. M. on January 4, 1921 in the following manner. Previous to the accident he was transferred from inside machine work to the yard. The weather was rather severe and at this particular time there were high winds. On the day mentioned, while he, with three other men, was using a crowbar to roll a heavy pipe into place, he felt a sudden pain below the angle of the left scapula. He was pulling rather hard at the crowbar, but was not using his full strength nor working harder or in a more strained position than his assistants. On the following day he did not report for work, and on visiting his home we found that his temperature was 102°, and his pulse 106. He was perspiring profusely. His temperature gradually came down and in three weeks he came back to work. The only local physical sign was tenderness in the angle of the scapula. There was no redness and no swelling. Motion of the right arm was limited but only in so far as the scapular action was brought into play. It was evident that this was not altogether an accident, but just how much of the syndrome was accident and how much disease, is very difficult to say. The patient demanded a diagnosis, and when he was informed that it was "lumbago" he remarked, "Doc, I cannot collect on an accident policy for that." The case was reported as an accident and so carried by the Industrial Commission even though we felt that disease played perhaps the most prominent rôle.

In this case we have a disabled back due to an acute febrile condition. In all probability the strain was nothing more than a coincidence, yet this case was reported as an accident. During certain seasons of the year, mostly in the spring and autumn when there are frequent changes in the weather, we have "crops" of cases similar to the last two. Following an abrupt change in the weather from warmer to colder we are always certain to find such cases.

In each of the three cases cited, the employee felt that he was hurt and was willing to hold the employer responsible. Indeed, there appears to be a growing tendency on the part of employees to hold the employer responsible for all manner of cases.

A review of Bulletin 272 of the U. S. Bureau of Labor Statistics (2), covering compensation cases in various states of the United States and in Canada, shows the greatest diversity of opinion in parallel cases as to what constitutes an accident, and how and when subsequent disease or death may be considered a result of accident. The tendency seems to be gradually to broaden the classification of conditions for which compensation may be paid. Out of the confusion which has arisen, as to what are really reportable injuries, we have adopted the following rule of action: As soon as possible after the injury, real or imaginary, we fill in a blank similar to the questionnaire shown in Figure 1. This will tell exactly what happened, and it will later be found of very great value to have recorded the exact statement of what actually happened as given by the employee at the very earliest moment following examination by the doctor. Lacking this clear, definite statement from the patient, the industrial physician will find himself at a very great disadvantage when presenting the case before the Industrial Commission. The borderline between accident and disease is so indefinitely drawn that, when a contest is arranged and the employee has been instructed by his attorney, he may

easily, intentionally or unintentionally, by inserting a few simple words such as "slipped" or "fell," change the entire complexion of the case.

It seems highly desirable that the employer, before assuming responsibility for the many questionable injuries, should request a hearing before the Industrial Commission in order to determine the responsibility in the particular case in question. This is a long, tedious and tiresome method, and one which we seldom employ because of the fact that it tends to destroy the confidence of the patient in the physician if there is any contest before treatment is undertaken.

The nature of the case often makes it difficult or impossible to request a hearing before the Industrial Commission, as in the instance of G. A. (*vide supra*). Because of the fact that the physician who has done much industrial work will not care to go frequently before the Commission to testify, it is not desirable to hold too many hearings, since they tend to break down the close co-operation which should exist between a physician and his patient. There is also a great deal of difficulty due to the fact that it may take weeks or months for the Commission to arrive at a decision after the case has been given a hearing. During this time the patient is without treatment unless the employer wishes to assume responsibility before the decision is made. If he adopts this method, it really offsets the purpose of having a hearing.

In answer to the question, "When are disabilities of the back arising out of patho-

FIGURE 1

QUESTIONNAIRE REGARDING INJURY

Name .....

Address.....Dept. .....

How long with company?.....When did accident occur? .....

What happened? .....

.....

.....

.....

What were you actually doing when the accident occurred? .....

.....

.....

Is this your regular work? .....

Did you slip or fall, or were you struck? .....

If you lifted an object, what was the weight? .....

Did you have any assistance? .....

Witnesses to accident .....

.....

Did anything unusual happen which you believe caused this injury?.....

.....

.....

Whom do you blame? .....

Have you ever had any injuries or accidents before? .....

Did you report accident to anyone? .....

Date.....M.D.

logical conditions called reportable accidents?" we are frank to admit that in many instances we are unable to decide. It is our belief, however, that many cases *now* reported as accidents need not be so carried. We feel that, by the application of the methods already outlined, we have been able to diminish the number of reportable cases. Inasmuch as in this state the power of determining what is an accident lies in the hands of the Industrial Commission, the logical thing to do seems to be to bring the case early to the attention of the Commission and ask for a decision. The physician who has at hand a careful detailed record of the events attending the so-called "accident," together with his physical findings, will always be in a better position to furnish satisfactory testimony before the Commission than the physicians who fail to have such a record. When an employee has gone on record as having stated that the disability developed in this or that way, he is not so apt to change his mind later, especially if he knows that his physician has a typewritten sheet at hand on which is contained the statement which he made at the time of injury. It is only reasonable to feel that such a statement must have some weight before the Commission, in view of the fact that it was taken at the time of the injury.

Before reporting any borderline cases, however, it is of greatest benefit to have a thorough physical examination and laboratory study of the case. As pointed out above, these studies will frequently reveal some chronic condition as the underlying cause of the disability. It is much more satisfactory and conclusive to have at hand the information which these studies bring to light, than to report a borderline case to the Commission as an accident and be compelled to furnish such information at a later date.

Under the existing compensation law in New York State, the employer will gradually be compelled to have a complete physical survey of all new employees. There would be many fewer deaths from syphilis aggravated by back injury if there were more routine Wassermann tests; X-ray studies of the chest would help to reveal pulmonary tuberculosis; and urine examinations would disclose diabetes and nephritis. These chronic diseases contribute to the greatest number of death claims in our experience. Each one, we believe, could have been avoided if our preliminary entrance examination had been sufficiently thorough, and often enough repeated.

If the employer will, by job analysis, inform the medical department what is expected from a new employee, and will supply the department with adequate personnel, laboratories and other facilities, he may hope to cut down the number of death claims and borderline back injuries. In this way only can he succeed in reducing these cases to a minimum. Laboratory examinations can necessarily be done more cheaply and more effectively in great numbers of cases than they can be done by a physician working on an individual case. It is in such work as this that the industrial physician can make his greatest contribution to the employer, the employee, and the community.

BIBLIOGRAPHY

1. Osgood, R. B.: Back Strain — An Accident or a Disease. Proc. Fourth Ann. Meeting Am. Assn. Indust. Physicians and Surgeons, June 9, 1919, p. 88.

2. Clark, L. D., and Frincke, M. C., Jr.: Workmen's Compensation Legislation of the United States and Canada. U. S. Bur. Labor Statis., Bull. 272, Jan., 1921, pp. 106–135.

PICRIC ACID IN INDUSTRIAL SURGERY*

ALFRED G. BOLDUC, M.D.
Company Physician, The Babcock & Wilcox Company, Bayonne, N. J.

PICRIC acid, $C_6H_2(NO_2)_3(OH)$, or trinitrophenol, is an odorless substitution product of phenol, and occurs in light yellow crystals or needles. Heretofore, it has had very limited use in the practice of medicine, being chiefly employed in a 1 per cent. aqueous solution as a dressing for superficial burns, for erysipelas, and as an anthelmintic. During the World War, however, the British Army Medical Corps (1) used a 5 per cent. solution of picric acid in 95 per cent. alcohol as an antiseptic in open wounds and for preparing the skin preceding minor and major operations, and had very gratifying results.

During the last two years I have treated approximately 4,000 cases of minor cuts, severe lacerations, punctured wounds, compound fractures (principally of the bones of the hands and feet) and other cases common in an industrial plant, and have used as the antiseptic, in all these cases, a 5 per cent. solution of picric acid in 95 per cent. alcohol. In fact, I have entirely discarded tincture of iodine. Practically all wounds that were sutured healed by primary intention and without infection, and better results were obtained with the use of picric acid in cuts and lacerations than were formerly obtained with the use of iodine. The wound, as a rule, remains clean and heals more quickly. From my experience, I think that I am justified in saying that picric acid (5 per cent.) can be applied to any part of the body, excepting the eye, without any untoward results. It can be used as an antiseptic for any condition for which iodine is used, and with better results. It is less irritating to the skin than iodine; it has mild anesthetic qualities; it is staple; it is less toxic; and last, but not of least importance, it is comparatively cheap.

It has been demonstrated that the penetrating power of picric acid on the skin is about the same as that of other germicides, *i. e.*, it penetrates only as far as the stratum corneum. The tanning qualities of picric acid are an important factor in the treatment of wounds. Pedicles of tanned skin form over areas which are painted with it, and in this tanned area are emmeshed the bacteria, which are prevented from entering the wound and spreading over the adjacent area of skin. This is theoretical, of course, but the principle is sound and plausible. The main fact is that in the cases mentioned above picric acid was an efficient antiseptic.

I have prepared the skin preceding minor operations with the alcoholic 5 per cent. picric acid, and have seen very few cases of infection. In at least one large New York hospital (2) picric acid is used exclusively in preparing the skin preceding major operations. Gauze saturated with a 5 per cent. aqueous solution of picric acid has the advantage over sterile gauze in that it is antiseptic and can be made absolutely sterile by live steam sterilization. If the gauze is then allowed to dry, an ideal surgical dressing results.

There is, however, one great objection to picric acid which should be mentioned here — namely, the tenacity with which the stain clings to the skin. I have as yet found no reagent that will entirely remove it from the skin, although it is easily removed from clothing and dressings by simply washing them in water. As picric acid in the crystal state is highly inflam-

* Received for publication Aug. 17, 1921.

mable, care must be taken to keep it away from open flames.

In conclusion, I wish to give the following list of the advantages of picric acid over iodine and other similar antiseptics, as observed in my clinical experience and as substantiated by laboratory findings:

1. Its comparative cheapness
2. Its mild anesthetic qualities
3. Its stability
4. The fact that it does not irritate the parts to which it is applied
5. Its non-toxic qualities (even when used in large amounts over extensive areas)
6. Its power of hastening healing, the wound resulting in a smooth cicatrix
7. The fact that it can be applied to any part of the body, excepting the eye, with absolute safety.

BIBLIOGRAPHY

1. Farr, C. E.: Picric Acid in Operative Surgery. Ann. Surg., 1921, **73**, 13.
2. Ochsner, A. J.: General Surgery. Vol. 2. Chicago, The Year Book Publishers, 1920.

SUGGESTIONS FOR CUSPIDORS IN INDUSTRIAL PLANTS*

H. F. SMYTH, M.D., DR.P.H.

Assistant Professor of Industrial Hygiene, School of Hygiene, University of Pennsylvania

WHILE attending the recent annual meeting of the National Association of Industrial Physicians and Surgeons the author was asked by an industrial physician for a large rolling mill if he could give him any suggestion for solving the problem of cuspidor location in the mill. There seems to be no suitable place for the ordinary metal cuspidor; it is always getting in the men's way and becoming battered and banged beyond usefulness, or being upset and its contents spilled. If no cuspidors are provided, however, the workmen are constantly expectorating promiscuously on the rolling floor or in accumulations of dirt and dust, and the partially dried sputum, if it contains infectious micro-organisms, becomes a menace in the form of dust. As the suggestion given by the author seemed to the plant physician to be a practical solution of this problem, it is given here in the hope that it may be of service to others and adaptable in other industrial locations.

The suggestion made was to have the ordinary trumpet-mouthed metal cuspidor or a modified two-piece fiber cuspidor set in a concrete pit (Figures 1, 2 and 3) so that its top is level with the floor and consequently does not offer an obstruction to the worker nor get in the way of working materials or tools. A location can certainly be found for the placing of such pits not too far from the place of work and yet where the open mouth of the cuspidor will not offer an accident hazard to the worker's heel or toe. If this cannot be done, the top of the opening may be covered with a coarse grating which can be swabbed off periodically with a disinfectant.

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The opening for the cuspidor should be in the center of a 3-foot circular or square steel or concrete plate which should be kept free from dust or clutter and should be swabbed off daily when the cuspidors are removed for cleaning. Removal of the cuspidors for cleaning can be conveniently and

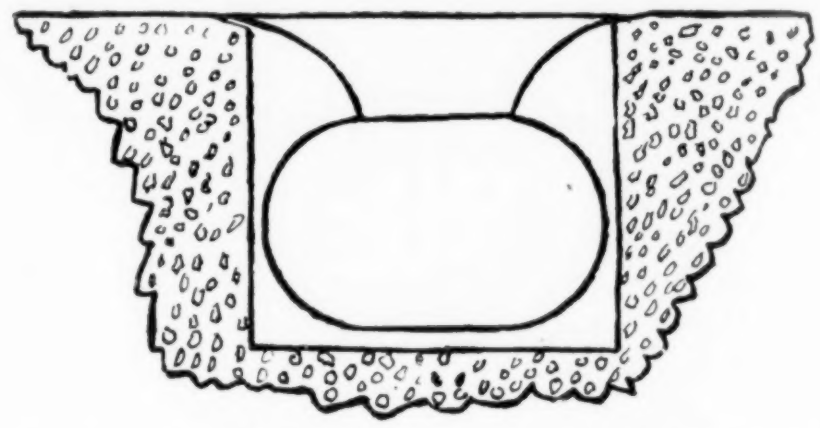

FIG. 1. — Cross section of metal cuspidor in concrete pit.

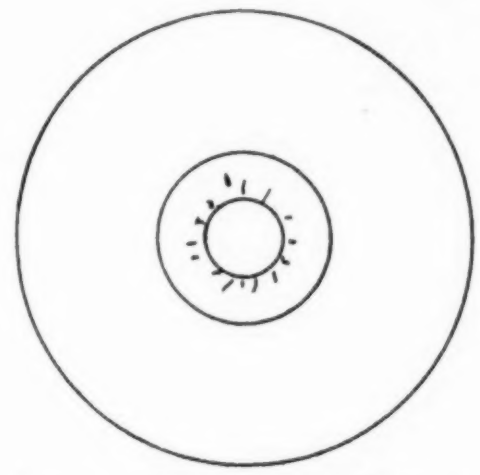

FIG. 2. — Top view of Figure 1.

safely accomplished, without touching any contaminated surface, with the use of expanding metal tongs. If a two-piece fiber cuspidor is used, the flare top must extend several inches beyond the sides of the bowl so as to give a surface to engage the edges of the pit.

For many other shop locations the same idea can be used of having a stationary, permanent location for a cuspidor so placed as to be free from any danger of upsetting or denting. Where feasible, the cuspidors can be sunk in a raised concrete block just a few

inches larger in diameter than the opening for the cuspidor, or possibly, better still, the cuspidor can rest in an iron ring attached to the side of a press, lathe, or other machine. (See Figure 4.)

Where many cuspidors are used in a large plant, the question of a safe and efficient means of cleaning them is not an unimportant one. Cuspidors should contain a small amount of liquid, preferably some cheap disinfectant as lysol, creolin, or other cresol preparation. They should be collected daily, if much used, and should be thoroughly cleaned before replacing. In a large plant, a hand truck can be provided to carry clean cuspidors and remove soiled ones for cleaning. This truck may also have a place for a jar of disinfectant with a swab for cleaning the surface surrounding the pits and the gratings, when these are necessary. Cuspidors can be easily and simply sterilized by inverting over a steam jet such as is used in many dairy farms for sterilizing large milk shipping cans. They may be placed over hoppers draining into the sewage system.

In some instances the removable cuspidor may be dispensed with entirely and replaced by metal or concrete funnels set in the floor and draining into the sewage system or into sand pits. The funnel should be swabbed out regularly and thoroughly with disinfectant solution.

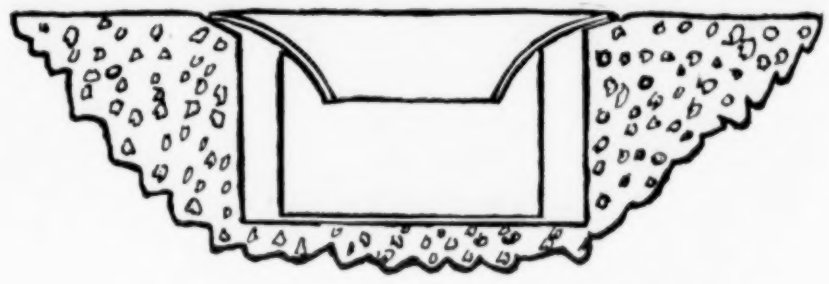

FIG. 3. — Two-piece fiber cuspidor in its pit.

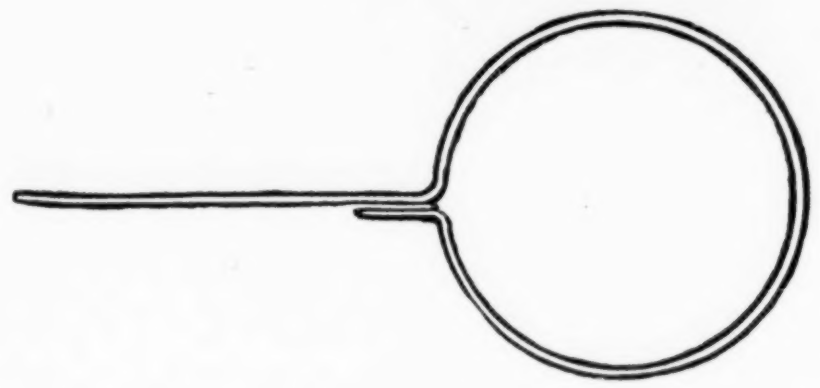

FIG. 4. — Strap iron ring to be bolted to machine as support for metal cuspidor.

The accompanying drawings may, perhaps, give a clearer idea than the text of some of the suggestions made above.

SPRAY INFECTION *

S. R. DOUGLAS AND LEONARD HILL

(From the National Institute for Medical Research, Hampstead, London)

IN the crowding together of human beings in factories, public conveyances, restaurants, cinemas, etc., one of the factors that tells against health is massive infection with organisms sprayed out from the mouth and nose by the carriers of pathogenic germs. In the open air such infection is negligible and good ventilation and proper spacing out can largely mitigate the massiveness of infection in places where people congregate indoors. The following research has been directed toward finding out how certain conditions affect the massiveness of spray infection.

I. The Effect of Humidity of the Air

Trillat and Mallein (1) compared the influence of humidity and dryness of the air on the duration of the suspension of a spray of microbes by spraying into bell glasses 4 cg. of an emulsion of microbes, the emulsion being made by diluting 1 cg. of a solid culture with 50 c.c. of water. Petri dishes were exposed after three and ten, or fifteen and twenty minutes, and the number of colonies counted after incubation of the culture medium which coated the dishes. Their figures show a greater number of colonies in air with 60 per cent. humidity than in dry air, a much greater number in supersaturated air, and a still greater number in air sprayed with some food substance, such as bouillon. They suggest that the microbes grow and multiply in the droplets of bouillon when suspended in air. The method is obviously open to error, as there is no guarantee that the spray in each bell glass is of the same order and distribution. We have failed to confirm their results in the case of relatively humid and dry air.

The method which we employed in our experiments was as follows: Two bell glasses were selected of equal size and with a ground flat edge at the bottom, and a tubulure at the top. The edges were vaselined and brought into apposition, and the nozzle of a spray inserted through one of the tubulures (Fig. 1). The bell glasses were placed in a horizontal position. Three strokes of the spraying pump were then made and the tubulure closed. The two bell glasses, now held in apposition vertically, were inverted four times at intervals of thirty seconds, so as to mix the suspen-

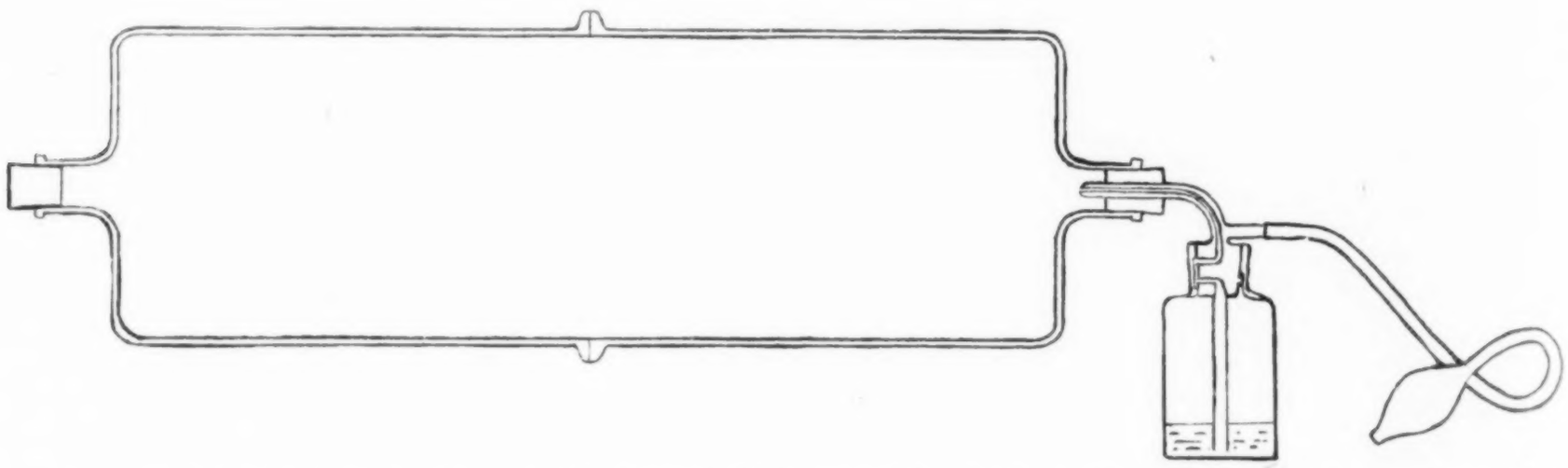

FIG. 1. — Diagram showing the two bell glasses held in apposition horizontally, and nozzle of spray inserted through one of the tubulures.

* Received for publication July 5, 1921.

sion equally. They were then gently separated and each one placed on a glass plate (Fig. 2) for transport, and then over the central orifice in the cover of one of the two chambers in which the Petri dishes were exposed (Fig. 3). These chambers were cylindrical and made of glazed earthenware. The Petri dishes were

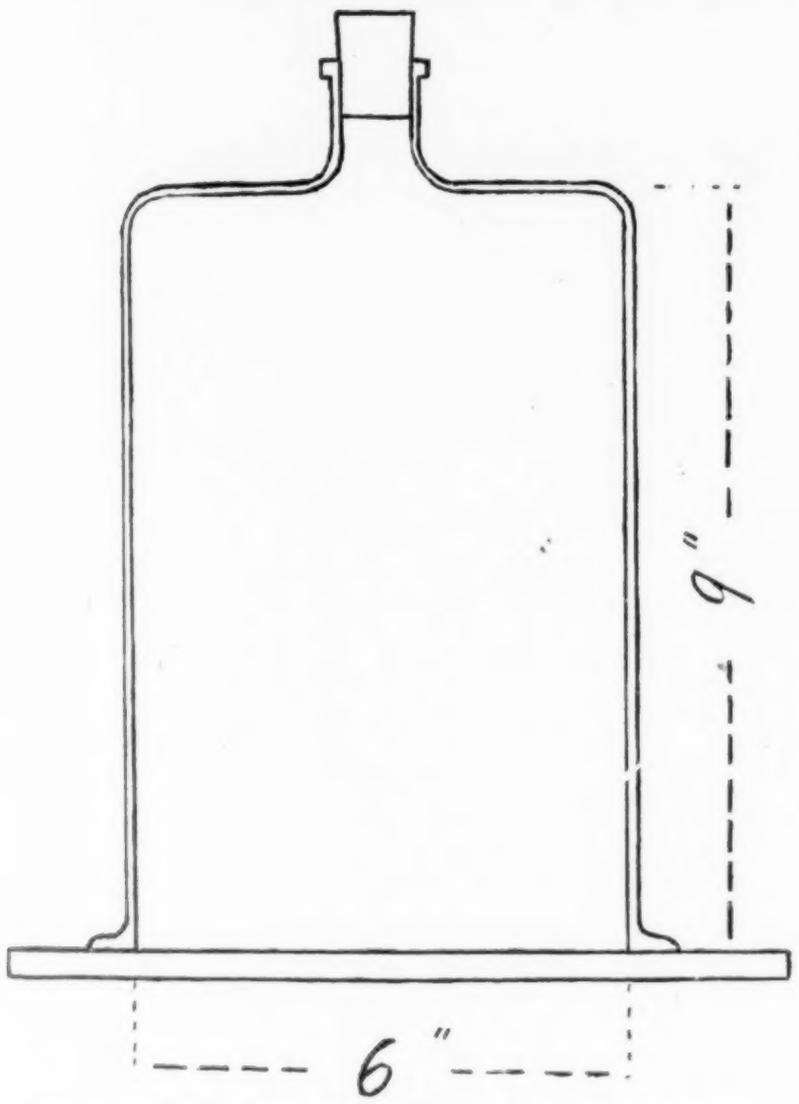

FIG. 2. — Bell glass on a plate ready for transport.

placed on a stand about 6 inches from the bottom of the chamber. The covers of the cylinders were glass and their apposition secured to the flat-topped edge by vaseline. A central circular orifice cut in the glass cover was closed by another glass plate curved on one side to fit the edge of the bell glass and so arranged that it could be pushed aside when the bell glass was sl'd into position. To the cover of each Petri dish was affixed a lump of hard wax to which a string was attached. The strings passed through pinholes in the glass cover closed by plasticine, so that by pulling on the strings the lids of the Petri dishes were raised and the culture medium exposed. One of the chambers was dried by a current of dry air, and basins of sulphuric acid and phosphorous pentoxide were placed on the floor in order to keep the air dry. In the other chamber which had been kept closed with a basin of water on the floor, the air was damp.

In the first experiment of this kind plates were exposed for two, five, and ten minutes after the bell glasses had been put in position. The result was that crowded colonies developed all over the plates in both the wet and the dry chambers In the next experiment we exposed the plates for two minutes at times shown in Table 1, with the result that the difference between the wet and dry chambers was found to be insignificant. The temperature of the chambers was 13°C. and the relative humidity of one 90 per cent., of the other 44 per cent., taken by wet and dry bulbs introduced at the end of the observation.

II. The Effect of Cold

Trillat and Mallein found that mice were much more readily infected when placed in a cold chamber and exposed for from one to three minutes to a suspension of the infecting microbes, than was the case when the chamber was warm. Moreover, they carried out the following experiment:

A chamber *A* of 50 liters' capacity was connected to a chamber *B* of 20 liters' capacity by a tube 10 m. long and 2 cm. in diameter. Into *A* the spray of microbes was made; in *B* mice were placed. If *B* were cooled the mice became infected, but no infection occurred if *B* were kept at the same temperature or warmer than *A*. Obviously the infection was due to condensation by cold of the air in *B*, and consequent drawing of the infected air from *A* into *B*.

We spread a microbic spray uniformly through two bell glasses *A* and *B* as in our previous experiment, and, after separating them, placed them on glass plates so that

they could be carried about without disturbing the contained spray. Bell glass *A* was then placed over the perforated cover

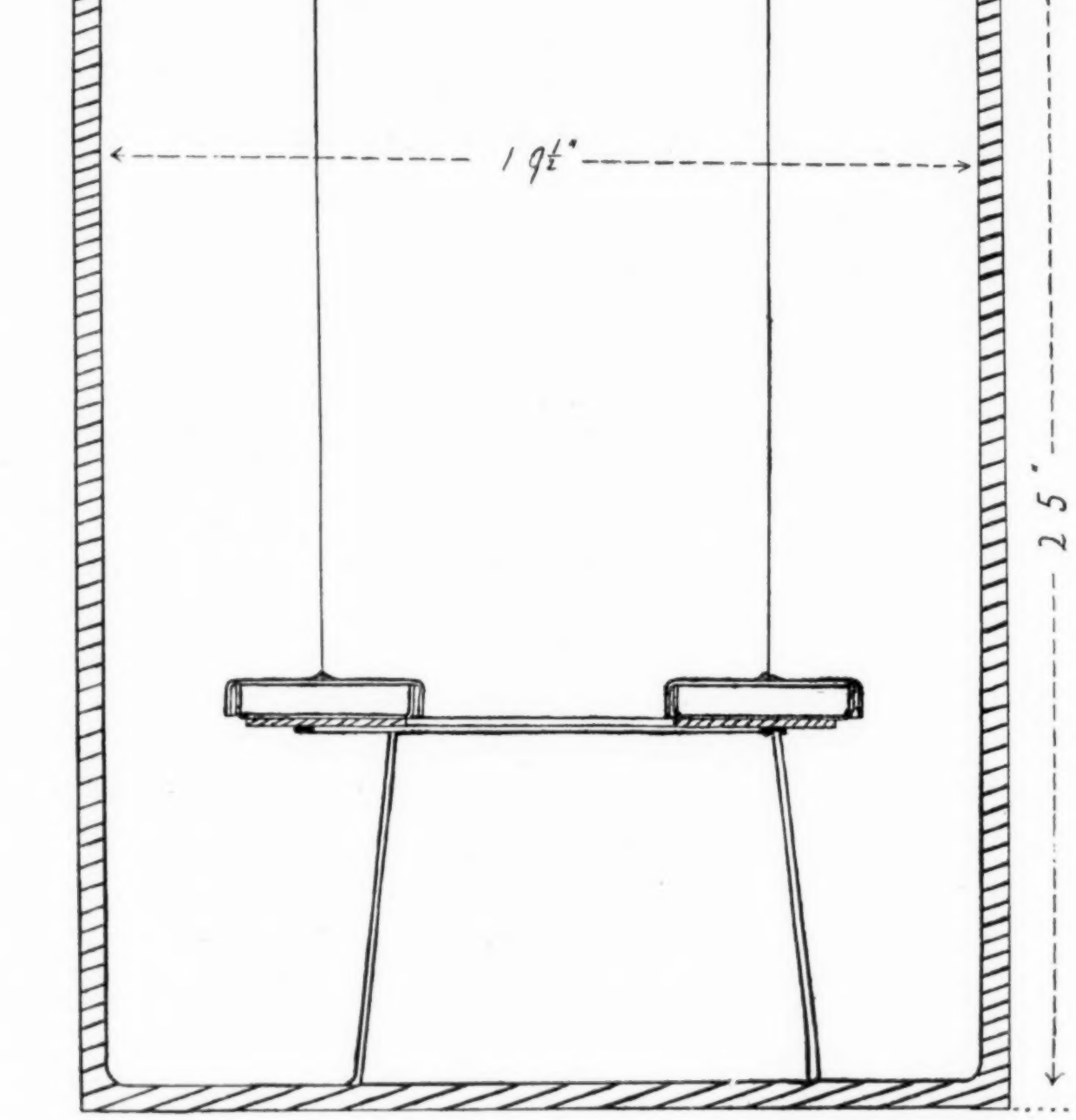

FIG. 3. — Diagram showing bell glass placed over the orifice in the cover of a chamber in which Petri dishes containing culture media are exposed.

of a chamber which had been placed in the hot room at 37.5°C. some hours previously, while *B* was placed over a chamber in the cold room at 3°C. Table 2 gives the results. We suggest that more microbes became at once affixed by the cold walls, together with the moisture which was condensed out, but the few organisms which escaped contact with the walls continued to float for a long time.

To test the suggestion of Trillat and Mallein in regard to condensation, we twined an iron wire in a series of bands round the outside of each of several test tubes, which were then sterilized inside paper covers. Some of the tubes were then filled with water at body temperature, and some with iced water, and after the paper covers had been removed were placed on a stand near the bottom of the chamber. A microbic spray was then made in a bell glass as before, and the spray allowed to settle from this into the chamber. After exposure for five minutes, a piece of wire was cut from each test tube and dropped into melted agar medium, and this, being shaken with the wire, was floated out into Petri dishes. Figures 4 and 5 show the difference in the results; many less colonies grew from the warm wires than from the cold wires.

In order to obtain a more exact idea of the difference in the number of organisms settling on the warm and cold wires, the following method was employed: After the tubes had been exposed, the wires were carefully removed with sterile forceps and dropped into a known volume (20 c.c.) of broth. The broth containing the wire was then thoroughly shaken so as to

loosen the organisms from the wire and distribute them in the broth. Measured quantities of the broth were then added to melted agar which, after thorough mixing, was poured into Petri dishes. These plates were incubated at 37°C. and the colonies were

TABLE 1. — RESULT OF EXPOSURE OF PLATES IN WET AND DRY CHAMBERS

Dry Air		Humid Air	
Exposure after	No. of Colonies	Exposure after	No. of Colonies
hours		*hours*	
1	17	1	33
2	8	2	11
3	5	3	5
4	0	4	1
5	0	5	0
6	2	6	1

counted after forty-eight hours. Taking the average of several experiments, the number of organisms (staphylococcus) found in a cubic centimeter of the broth, after it had been shaken with the wire, was 29 per c.c. in the case of the warm wire, and 120 per c.c. in the case of the chilled wire. It seems probable, then, that on coming

TABLE 2. — RESULT OF EXPOSURE OF PLATES IN WARM AND COLD AIR

Warm Air		Cold Air	
Exposure after	No. of Colonies	Exposure after	No. of Colonies
hours		*hours*	
1	400	1	26
2	20	2	6
3	0	3	2
4	0	4	3
5	1	5	3
6	0	6	0

into a crowded, warm room on a frosty day, hair, moustache, clothes, etc., will, owing to their lower temperature, affix microbes upon their surfaces in greater numbers than would be the case if the temperature were higher. Thus, too, Trillat's mice may have been more massively infected in the cold chamber.

The effect of a cold surface on suspended particles is shown in the following experiment: We took a glass tube 3 cm. in diameter and 1 m. long and inserted into either end of it a short U-tube through

FIG. 4. — Number of colonies growing from warm wires after five minutes' exposure to microbic spray.

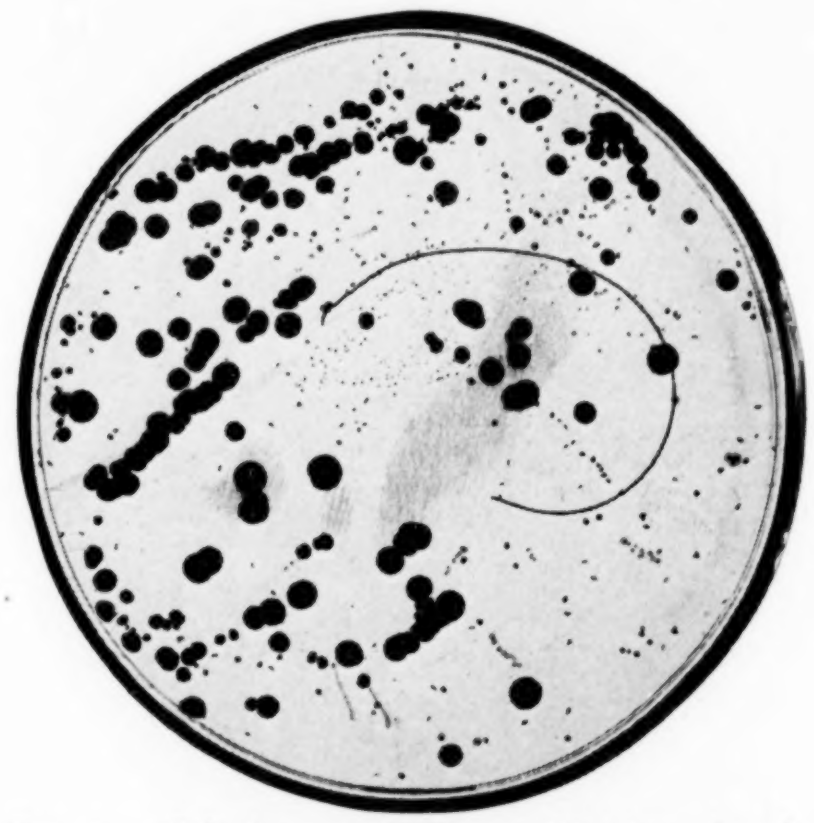

FIG. 5. — Colonies growing from cold wires after five minutes' exposure to microbic spray.

which circulated in one case iced water, and in the other case water at body temperature. We then drew tobacco smoke through the tube so as to fill it with a cloud of smoke from end to end. We found the smoke cleared round the end fitted with the cold U-tube and particularly round the

end of this tube, leaving a space as shown in Figure 6. Smoke eddies could also be seen at this place. At the end fitted with the test tube containing warm water no change appeared. The condensation of moisture of the air by the cold surface leads to many more particles, such as smoke and microbes, coming in contact with the surface, and they become fixed thereon, whether because they are carrying an opposite electrical charge, or otherwise, we cannot say.

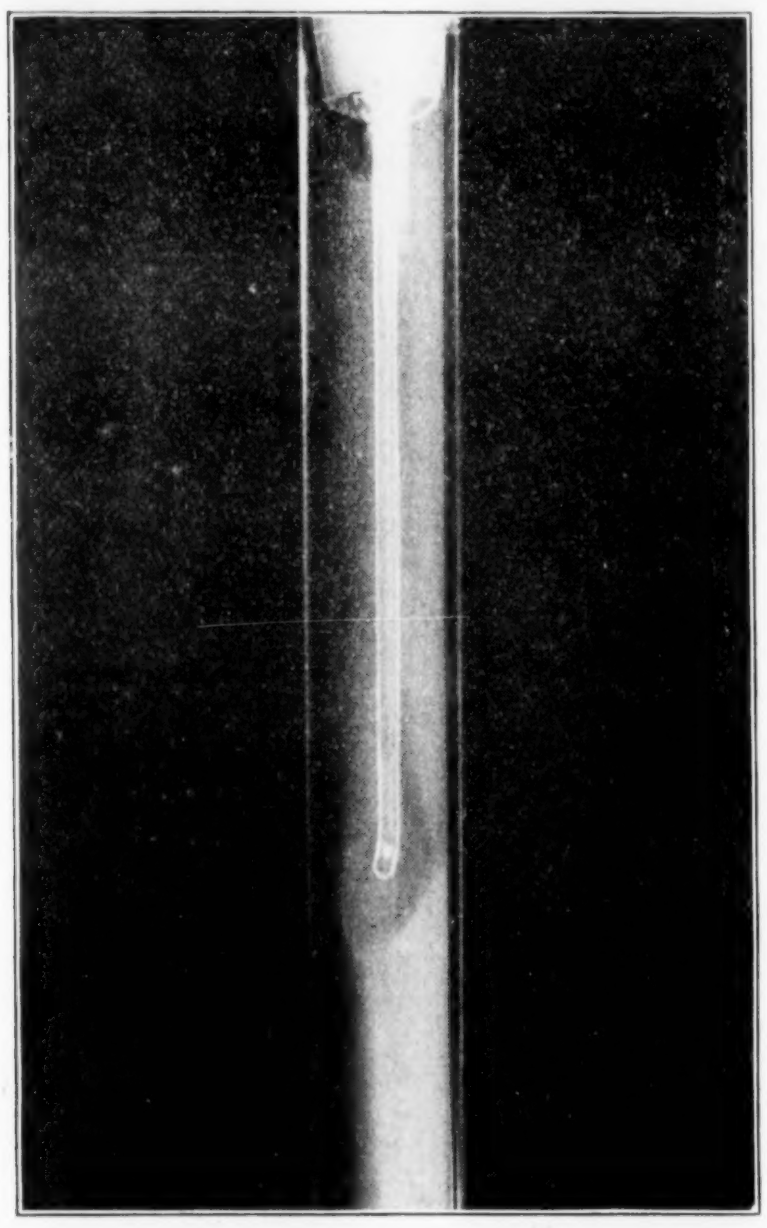

FIG. 6. — The smoke-free space at the end of the U-tube shows the effect of the cold surface of the U-tube on the suspended particles of smoke.

III. The Effect of a Current of Saturated or Dusty Air on Transport of Microbes

Trillat and Mallein state that either water-saturated or dusty air carries away from the surface of a culture many more organisms than does dry air. This statement we have confirmed. Dry air from a compressed air cylinder was passed over a culture of staphylococcus, which grew along the floor of a tube *A* placed horizontally. In sequence to this tube was another tube *B* lined with sterilized agar culture medium. Air flowed through the two tubes for two and one-half minutes at the rate of 10 liters per minute. Only one or two colonies grew subsequently in *B*. The experiment was repeated, but this time with air first bubbled through warm water to saturate it. Some of the water condensed in *B*; this was grossly infected.

In a third experiment, the dry air passed through a bottle in which some dry sterile talc was shaken to make a dust. Many more colonies appeared in *B* under these conditions than when dry air alone was passed over the culture. In a fourth experiment, saturated and dusty air was passed over the culture and this caused gross infection in *B*. We conclude, therefore, that particles of water or dust in moving air on hitting infected surfaces carry away the microbes from these surfaces and in this manner help to spread infection.

IV. Experiments Made to Investigate the Effects of Ventilation in Rooms Massively Infected with a Spray of Culture

We made a spray in an empty room (21 by 16½ by 13½ feet) heated by steam radiators, and exposing Petri dishes, usually five for each observation, compared the number of colonies formed, first, when the room was comfortably ventilated by open windows so that it felt fresh, and secondly, when the windows were all shut and the room felt close.

Seven and a half c.c. of a broth culture of a coliform bacillus (from a rabbit's intestine), diluted 1 in 5, were sprayed across the blast from a fan directed toward

TABLE 3. — AVERAGE NUMBER OF COLONIES RESULTING FROM EXPOSURE IN FRESH AND CLOSE ROOMS

No. of Plate	Exposure for Two Minutes after	No. of Colonies	
		Fresh Room	Close Room
	minutes		
1	immediate	1,593	1,468
2	5	446	634
3	10	54	272
4	15	38	118
5	20	1	76

the ceiling so that the organisms might be equally distributed throughout the air. The original culture contained about 300,000,000 living organisms per cubic centimeter, and it was found that by the above technic a

FIG. 7. — Photograph of plate 1 after exposure, immediately after spraying, in close room (upper half), and in ventilated room (lower half).

very even distribution of the organism was obtained. In the fresh room the dry bulb read 17.2°C., the wet bulb 12.8°C., and the dry kata-thermometer reading was 6°. In the close room, the dry bulb read 21.4°, the wet bulb 15.5°, and the dry kata-thermometer 4.2°. The Petri dishes were exposed for two minutes immediately, and at intervals of five, ten, fifteen and twenty minutes after making the spray. The number of colonies in the five plates after each exposure agreed very closely; the average number of colonies being shown in Table 3. The area of culture media exposed was very nearly equal. Figures 7, 8, and 9 are from photographs

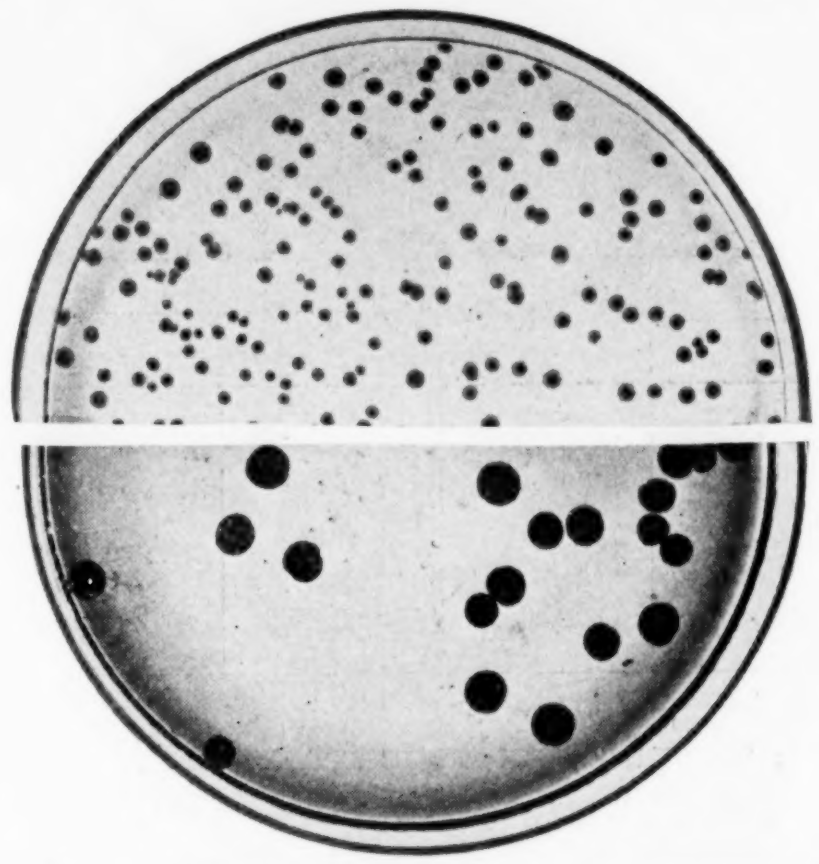

FIG. 8. — Photograph of plate 3 after exposure, ten minutes after spraying, in close room (upper half), and in ventilated room (lower half).

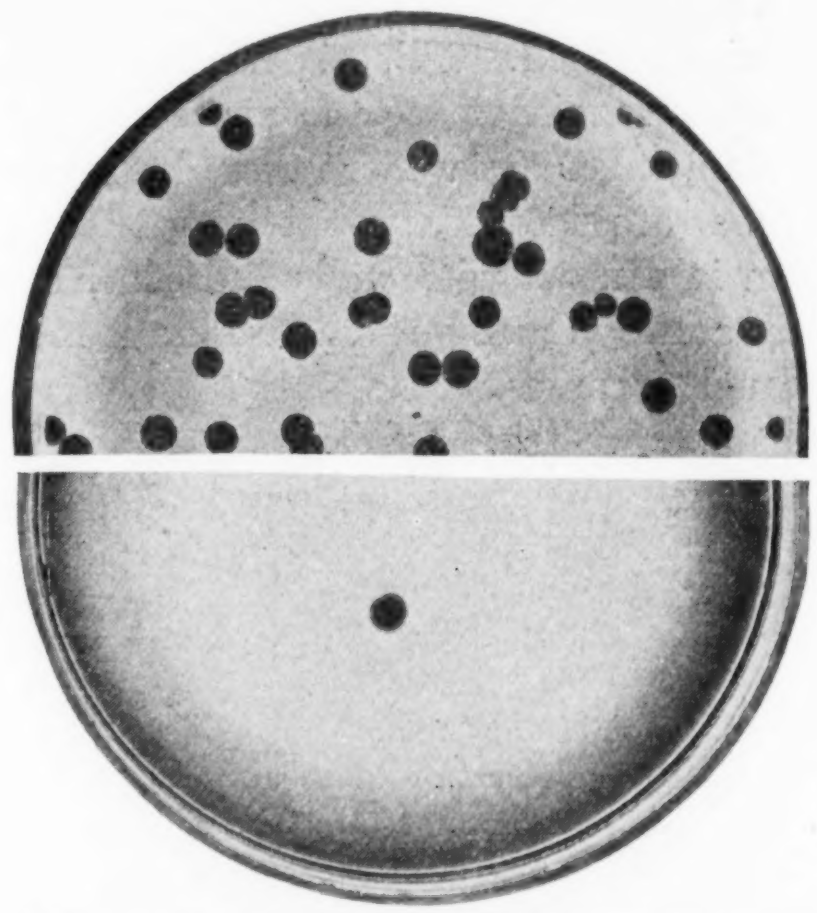

FIG. 9. — Photograph of plate 5 after exposure, twenty minutes after spraying, in close room (upper half), and in ventilated room (lower half).

of plates 1, 3, and 5; the close room plate being shown in the upper half in each case. It is clear, then, that opening the window enough to change close conditions into

those which feel fresh lessens massive spray infection greatly.

We next repeated the experiment in the close room, first, with the fan running so as to keep the air in constant movement,

TABLE 4. — AVERAGE NUMBER OF COLONIES RESULTING FROM EXPOSURE IN CLOSE ROOM WITH FAN RUNNING AND WITH FAN AT REST

No. of Plate	Exposure for Two Minutes after	No. of Colonies	
		Fan Off	Fan On
	minutes		
1	immediate	1,750	1,700
2	5	680	510
3	10	425	230
4	15	200	84
5	20	97	40

and, secondly, with the fan at rest. With the fan at rest the dry bulb read 22.5°, the wet bulb 14.5°, and the dry kata-thermometer 4.1°. With the fan running the readings were 22°, 14°, and 5.6°. Table 4 gives the average number of colonies formed. This experiment shows that the movement of the air, caused by the fan, takes away more than double the number of microbes, probably by bringing them in contact with walls and other surfaces and by driving them out of the room through crannies.

Lastly, we tried the experiment in the relatively dry close room, and in the same room made moist by a number of baths of water kept boiling by Bunsen burners, and by water scattered over the floor and walls. In the dry close room the dry bulb read 21.2°, the wet bulb 12°, and the dry kata-thermometer 4.3°; in the moist close room the readings were 23.5°, 20.5°, and 4.0°, respectively. The number of colonies is recorded in Table 5. In the moist room the number of microbes was notably more reduced, partly, we suggest, owing to their condensation together with water vapor on the walls and other surfaces, partly owing to stronger outward currents being set up through crannies because of the greater lightness of the moist air, and

TABLE 5. — AVERAGE NUMBER OF COLONIES RESULTING FROM EXPOSURE IN DRY AND MOIST CLOSE ROOM

No. of Plate	Exposure for Two Minutes after	Dry Close Room	Moist Close Room
	minutes		
1	immediate	1,540	2,610
2	5	690	1,025
3	10	540	452
4	15	215	157
5	20	121	68

partly owing to the fact that a large number of organisms must have been destroyed by the twelve or more Bunsen burners which were employed in heating the water used to saturate the air.

BIBLIOGRAPHY

1. Trillat, A., and Mallein: Sur le sort des projections microbiennes dans l'air. Influence de l'humidité. Compt. rend. Acad. d. sc., 1920, **170**, 1291. Expériences de transmission d'une épidémie chez les animaux par l'intermédiaire de l'air. Influence de la température. *Ibid.*, 1529.

CARBON MONOXIDE, ILLUMINATING GAS, AND BENZOL: THEIR EFFECT ON BLOOD COAGULATION TIME*

HENRY S. FORBES AND LOUISE HOMPE

From the Laboratory of Applied Physiology, Harvard Medical School

IN carbon monoxide poisoning, pathologists describe hemorrhages in the brain, muscles, lungs, and other organs (1). Some authors state that the blood postmortem remains fluid in the vessels much longer than usual and does not readily clot when withdrawn (2). Others say that carbon monoxide favors coagulation (3). On account of these diverse findings and because of differences of opinion regarding the mode of action of the gas, it seemed worth while to determine carefully the coagulation time of the blood of animals gassed with carbon monoxide and to note any evidence of blood destruction (*e. g.*, hemolysis).

Convincing proof has been brought forward by the physiologists that this gas has no direct harmful action upon nerve cells or other tissues, but injures solely by robbing these tissues of oxygen through the formation of a compound with hemoglobin which is not stable but which can be replaced by oxygen under suitable tension (4) (5). Many of the cases described in the literature as carbon monoxide poisoning are in reality, however, due to illuminating gas. The pathological pictures in poisonings by these two gases may well differ. Illuminating gas is complex and has been shown to be more toxic than is pure carbon monoxide, the chief additional poison being benzol (6) (7). The other toxic constituents — xylene, ethylene, etc. — appear to be much less important so far as is known at present. It has been shown by Hurwitz and Drinker (8) that repeated subcutaneous injections of benzol can cause delayed coagulation, but this does not happen immediately. According to their figures, the change is slight after four days from the first injection, and is not marked till the tenth day; therefore, a change is hardly to be expected, even from intensive gassing, within the time limits of the present experiments. We have tried to find out in these experiments whether or not, under controlled conditions, pure carbon monoxide, illuminating gas, and pure benzol have any measurable effect on coagulation time.

* The authors wish to express their thanks to Dr. Cecil K. Drinker and Dr. Katherine R. Drinker for valuable suggestions and help. Received for publication Sept. 12, 1921.

METHOD

Cats anesthetized with urethane or ether supplied control samples of blood. With urethane the dosage was 10 c.c. of a 25 per cent. solution per kilo weight of cat given by stomach tube. One carotid was exposed and 2 c.c. samples * were drawn directly into a cannula-tipped pipette. This was previously coated with a saturated ether solution of vaseline, the ether being afterwards carefully expelled. From the pipette 1 c.c. of blood was delivered into the bottom of each of two test tubes, which were thoroughly clean and dry, and of uniform diameter. These tubes were kept in a water-bath at 31° to 32° C. After standing ten minutes, they were tilted slightly once every five minutes. The end point was the firm holding of the clot so that the blood did not run down the side when the test tube was inverted. Time was taken from the moment the blood entered the pipette. A few determinations were made on blood oxalated and recalcified after the method of Howell (9).

* Occasionally 3 c.c. samples were taken and put into three test tubes.

After control samples had been taken from the urethanized animal, the gas was given from a Douglas bag by a tracheal cannula, fitted with inspiratory and expiratory valves. In the different experiments the duration of gassing varied from thirty minutes to seven and one-half hours. For the longer periods, instead of being permitted to inhale the gas by tracheal tube, the animal was placed in a box of 760 liters' capacity, to which a measured amount of gas was added. An electric fan kept the air in motion, and the excess of carbon dioxide and moisture was absorbed by soda lime.

The carbon monoxide, which we used, was made from formic acid and sulphuric acid heated to 70° to 80°C., and the gas passed through strong sodium hydrate solution and collected in a bottle by displacement of water. The illuminating gas was taken from the laboratory gas jet. It was supplied by the Boston Consolidated Gas Company, and the figures giving the average monthly percentage of carbon monoxide were obtained through the courtesy of the chief chemist of the company. The benzol used was "Benzene (Benzol) Merck." The percentage of vapor inhaled by the animals was not determined but was of sufficient concentration to keep them unconscious.

Experimental Data

Eleven experiments have been chosen from the total number performed. A number were discarded because of lack of uniformity among the controls before a constant temperature bath was used. In the prothrombin tests, uniformity was obtained without the use of a water-bath, and it was, therefore, omitted.

The accompanying protocols show the extent of the individual variations in coagulation time.

Protocol 1. — Cat 1. Weight 3.1 kg. Urethane 31 c.c. 25 % solution given 2 hours and 22 minutes before gas started. Gassed 82 minutes with 0.5 % CO.

Normal Blood

Sample	Coagulation Time Tube 1 *min.*	Tube 2 *min.*	Tube 3 *min.*
A	25	25	25
B	20	20	26

CO Blood

A taken 21 minutes after starting gas						20	20	25
B	"	38	"	"	"	"	20	20	..
C	"	55	"	"	"	"	20	20	..
D	"	72	"	"	"	"	20	20	..
E	"	82*	"	"	"	"	20	20	..

* Heart had stopped when sample was taken.

Protocol 2. — Cat 2. Weight 2.9 kg. Urethane 29 c.c. 25 % solution given 1¾ hours before gas started. Gassed 61 minutes with 0.5 % CO.

Normal Blood

Sample	Coagulation Time Tube 1 *min.*	Tube 2 *min.*
A	35	35
B	30	26

CO Blood

A taken 10 minutes after starting gas						30	30
B	"	24	"	"	"	"	35	31
C	"	40	"	"	"	"	30	26
D	"	48	"	"	"	"	25	20
E	"	56	"	"	"	"	35	35
F	"	61*	"	"	"	"	20	30

* Heart stopped 2 minutes before sample was taken.

Protocol 3. — Cat 3. Weight 3 kg. Urethane 30 c.c. 25 % solution given 1½ hours before gas started. Gassed 47 minutes with 0.6 % CO.

Prothrombin Test

Oxalated Blood *drops*	1% $CaCl_2$ *drops*	Coagulation Time Control *min.*	CO Sample *min.*
5	1	9	8
5	2	9	10
5	3	11	11
5	4	12	11

Oxalated Plasma *drops*	1% $CaCl_2$ *drops*	Control *min.*	CO Sample *min.*
5	1	20	22
5	2	21	20
5	3	20	20
5	4	20	20

PROTOCOL 4. — Cat 4. Weight 2.2 kg. Urethane 18 c.c. 25 % solution given $2\frac{3}{4}$ hours before gas started. Gassed 39 minutes with 0.7 % CO (in two periods with two 69-minute intervals).

Prothrombin Test

Oxalated Blood *drops*	1% $CaCl_2$ *drops*	Coagulation Time Control *min.*	Coagulation Time CO Sample *min.*
5	1	4	3
5	2	5	3
5	3	5	4
5	4	7	4

PROTOCOL 5. — Cat 5. Weight 2 kg. Urethane 20 c.c. 25 % solution given $2\frac{3}{4}$ hours before gas started. Gassed 30 minutes with 0.6 % CO.

Prothrombin Test

Oxalated Blood *drops*	1% $CaCl_2$ *drops*	Coagulation Time Control *min.*	Coagulation Time CO Sample *min.*
5	1	6	5
5	2	6	4
5	3	7	5
5	4	9	6

PROTOCOL 6. — Cat 6. Weight 2.5 kg. Urethane 30 c.c. 25 % solution given 1 hour before gas started. Gassed 34 minutes with 2 % illuminating gas (containing approximately 0.5 % CO).

Normal Blood

Sample	Coagulation Time Tube 1 *min.*	Coagulation Time Tube 2 *min.*
A	30	30
B	25	30

Illuminating Gas Blood

A taken	8	minutes	after	starting	gas		21	25
B "	15	"	"	"	"		20	25
C "	23	"	"	"	"		25	25
D "	28	"	"	"	"		25	30
E "	34	"	"	"	"		30	30

PROTOCOL 7. — Cat 7. Etherized 40 minutes till gas started. Gassed 5 hours in box with 0.5 % illuminating gas (containing approximately 0.12 % CO).

Normal Blood

Sample	Coagulation Time Tube 1 *min.*	Coagulation Time Tube 2 *min.*
A	15	10
B	20	10
C	15	15

Illuminating Gas Blood

A taken	$4\frac{1}{2}$	hours	after	starting	gas	....	15	10
B "	$4\frac{1}{2}$	"	"	"	"	....	20	10
C "	$4\frac{1}{2}$	"	"	"	"	....	25	10
D "	5	"	"	"	"	....	20	20
E "	5	"	"	"	"	....	20	10

PROTOCOL 8. — Cat 8. Etherized 35 minutes before taking control samples. Exposed to benzol vapor in box for 3 hours. Unconscious.

Normal Blood

Sample	Coagulation Time Tube 1 *min.*	Coagulation Time Tube 2 *min.*	Coagulation Time Tube 3 *min.*
A	25	20	..
B	25	20	20

Benzol Blood

A taken	3	hours	after	starting	gas	.....	30	20	..
B "	3	hrs.	and	5	m.	after starting gas	30	30	..
C* "	3	"	"	10	"	" " "	40	40	50

* Taken 1½ minutes after heart stopped.

Autopsy. — Blood as dark in arteries as in veins. Right lung congested, hemorrhagic, edematous; intestinal vessels appear contracted and pale, showing marked contrast to those of CO animals, which are always greatly dilated.

PROTOCOL 9. — Cat 9. Etherized before taking control samples. Exposed to benzol vapor in box for 3 hours. Unconscious.

Normal Blood

Sample	Coagulation Time Tube 1 *min.*	Coagulation Time Tube 2 *min.*
A	20	25

Benzol Blood

A taken	3	hours	after	starting	gas	.....	15	15
B "	3	"	"	"	"	.....	15	15

Prothrombin Test

Oxalated Blood *drops*	1% $CaCl_2$ *drops*	Coagulation Time Control *min.*	Coagulation Time Benzol Sample *min.*
5	1	3	3
5	2	3	3
5	3	4	3
5	4	4	4

PROTOCOL 10. — Cat 10. Etherized before taking control samples. Chilled by wetting and exposure to fan for 53 minutes. Rectal temperature reduced to 29.5°C. Exposed to benzol vapor in box for $3\frac{1}{2}$ hours after being warmed. Rectal temperature 33.5°C.

Normal Blood

Sample	Coagulation Time Tube 1 *min.*	Coagulation Time Tube 2 *min.*
A	25	25
B after exposure to cold	20	20

Benzol Blood

A taken after	1	hour	of	gas		.....	20	30
B "	"	1	"	"	"	.....	20	15
C "	"	$3\frac{1}{2}$	"	"	"	.....	17	17
D "	"	$3\frac{1}{2}$	"	"	"	.....	20	20

PROTOCOL 11. — Cat 11. Gassed preceding day for $7\frac{3}{4}$ hours with benzol vapor. Unconscious most of that time. Appears normal on day of experiment; no sign of paralysis. No ether or urethane given. No control samples taken. Exposed in box to benzol vapor for $7\frac{1}{2}$ hours. Red blood count 8,000,000; white blood count 13,000; blood smear shows polynuclears and platelets increased.

Benzol Blood Sample	Coagulation Time Tube 1 *min.*	Tube 2 *min.*
A taken after 6 hours and 24 minutes of gas	25	25
B " " 6 " " 45 " " "	20	15
C " " 6 " " 54 " " "	25	25
D* " " 7 " " 30 " " "	20	20

* Taken from abdominal aorta 2 minutes after heart stopped.

DISCUSSION

The experiments which we have reported show no constant change of coagulation time in the blood of cats gassed with any one of the three gases tested, and the prothrombin content was apparently unaltered. Evidence of hemolysis was lacking. Clear serum was always obtained unless mechanical injury to the red cells had occurred. The urine was never dark or smoky. Since no hemorrhages were found postmortem, it is apparent that the exact conditions of human poisoning were not reproduced, even by five hours of deep coma in the gas. The one possible exception is seen in Protocol 8 where the lungs showed some extravasation of blood. This animal's blood showed a lengthening of coagulation time in the last sample, though it is doubtful if this is significant, for the sample taken only five minutes before showed a normal time. Protocol 9, on the other hand, with the same duration of exposure to benzol showed a slight shortening of coagulation time, but this again can be disregarded because the prothrombin test taken at the same time was normal.

In fatal human cases of illuminating gas poisoning the patient often lingers in coma for one or two days before death. This condition we were unable to duplicate in animals. They either died in the gas or recovered entirely. The most probable explanation of this failure to reproduce hemorrhages or prolonged coma after removal from the gas is either that it affects animals differently from human beings or, more probably, that the period of gassing is shorter in these experiments than in the human cases.

CONCLUSIONS

Under the conditions of these experiments no measurable effect upon the coagulation time of the blood was found in cats gassed with carbon monoxide, illuminating gas, or benzol.

No evidence of hemolysis or of blood destruction was observed.

BIBLIOGRAPHY

1. Kober, G. M., and Hanson, W. C.: Diseases of Occupation and Vocational Hygiene. Philadelphia, P. Blakiston's Son and Company, 1916, p. 57.
2. Glaister, J., and Logan, D. D.: Gas Poisoning in Mining and Other Industries. New York, William Wood and Company, 1914, p. 340.
3. Rambousek, J.: Industrial Poisoning. London, Edward Arnold, 1913, p. 199.
4. Haggard, H. W.: Effects of Carbon Monoxide on Neuroblasts. To appear in Am. Jour. Physiol.
5. Haldane, J. S.: The Relation of the Action of Carbonic Oxide to Oxygen Tension. Jour. Physiol., 1895, **18**, 201.
6. Henderson, Y., and Haggard, H. W.: The Elimination of Carbon Monoxide from the Blood after a Dangerous Degree of Asphyxiation, and a Therapy for Accelerating the Elimination. Jour. Pharmacol. and Exper. Therap., 1920, **16**, 11.
7. Henderson, Y., and Haggard, H. W.: Personal Communication.
8. Hurwitz, S. H., and Drinker, C. K.: The Factors of Coagulation in the Experimental Aplastic Anemia of Benzol Poisoning, with Special Reference to the Origin of Prothrombin. Jour. Exper. Med., 1915, **21**, 401.
9. Howell, W. H.: The Condition of the Blood in Hemophilia, Thrombosis and Purpura. Arch. Int. Med., 1914, **13**, 76.

BOOK REVIEWS

The Assessment of Physical Fitness by Correlation of Vital Capacity and Certain Measurements of the Body. By Georges Dreyer, C.B.E., M.A., M.D., Fellow of Lincoln College, Professor of Pathology in the University of Oxford, Corresponding Member of the Royal Danish Academy of Letters and Sciences, and George Fulford Hanson, Late Lieutenant U.S.A. Medical Corps, Air Service. With a foreword by Charles H. Mayo, M.D., Rochester, Minn. Cloth. Pp. 127 with illustrations and index. New York: Paul B. Hoeber, 1921.

This book is a collection of tables through the use of which it is held possible to arrange individuals in the order of their physical fitness. The author has established certain relations between weight, sitting height, chest circumference, and vital capacity, which are indicative of good health. He does not include any of his data upon the validity of these relations but includes references to previous papers in which he has discussed the development of his conceptions.

The reader is given a series of tables with thorough directions as to their use for the following purposes:

"1. The determination of what are the normal proportions between the weight, the trunk-length, and the circumference of the chest.

"2. To gain evidence as to underfeeding or malnutrition during different stages of adolescent or adult life, as well as in various classes and occupations of the population.

"3. For the study of the different aspects of physical fitness as measured by vital capacity in its relation to weight, trunk-length, and chest-circumference; for the comparison of adolescents with adults, and of the male sex with the female; for the comparison of different trades, occupations, and classes one with another, referring all to a definite common standard.

"4. The application of these various measurements to patients with organic disease — *e.g.*, pulmonary tuberculosis—as well as to persons with functional disorders — *e. g.*, industrial fatigue, the fatigue of aviators, and so on."

Since the usefulness of Dreyer's tables can only be established through experience with them, no opinion can be expressed as to the soundness of these contentions. The whole subject is of such vital interest to industrial physicians that it is hoped they will at once begin to utilize and criticize the methods and standards which the author has furnished. — *C. K. Drinker.*

Occupational Affections of the Skin. Their Prevention and Treatment, with an Account of the Trade Processes and Agents Which Give Rise to Them. By R. Prosser White, M.D. Ed., M.R.C.S. Lond., Life Vice-President, Dermatologist, Senior Physician and Enthetic Officer, Royal Albert Edward Infirmary, Wigan; Vice-President Association Factory Surgeons; Life Fellow London Dermatologists' Society; Member Manchester Medical and Dermatologists' Societies; Hon. Life Member St. John Ambulance Association; Associate Editor, Journal of Industrial Hygiene. Cloth. Second Edition. Pp. 360 with illustrations and index. New York: Paul B. Hoeber, 1920.

The first edition of this book, published in 1915, proved itself of great worth in a comparatively neglected and difficult field. In this, the second edition, which is greatly amplified, useful material has been added to almost every chapter. Deserving of especial mention are the chapters on dermatitis venenata and the dermatoconioses. The added illustrations are excellent and the numerous references, which have been carefully and painstakingly compiled, will prove a great help to investigators in this line of work.

It is a book which fills a long felt want and deserves a prominent place in the library of every worker in industrial hygiene, while the dermatologist who reads it will soon discover that to him it is not a luxury but a necessity. It is to be hoped that in the future there will follow other editions to add to the literature in this complex and ever-widening field. — *E. Lawrence Oliver.*

HEALTH INSTITUTE OE THE AMERICAN PUBLIC HEALTH ASSOCIATION

One of the features of the Fiftieth Annual Meeting of the American Public Health Association is to be a Health Institute which will be held in New York City from November 8 to 11, the convention itself taking place the following week, November 14 to 18. The Institute is open to non-members of the American Public Health Association.

Among the demonstrations tentatively included in the program for the Industrial Hygiene Section of the Institute are:

Industrial Hygiene and Welfare Work of the New York Telephone and Telegraph Company.

Industrial Hygiene Work of the New York City Health Department.

Industrial Hygiene Work of the American Telephone and Telegraph Company.

National Industrial Conference Board Exhibit of Charts and Discussion of Cost of Industrial Welfare.

Industrial Welfare Work of the Metropolitan Life Insurance Company.

Industrial Hygiene Work of the New York City Health Department.